Cognition and the Take-Up of Subsidized Drug Benefits by Medicare Beneficiaries

ABSTRACT

Importance: Take-up of the Medicare Part D low-income subsidy (LIS) by eligible beneficiaries has been low despite the attractive drug coverage it offers at no cost to beneficiaries and outreach efforts by the Social Security Administration.

Objective: To examine the role of beneficiaries' cognitive abilities in explaining this puzzle.

Design and Setting: Analysis of survey data from the nationally representative Health and Retirement Study.

Participants: Elderly Medicare beneficiaries who were likely eligible for the LIS, excluding Medicaid and Supplemental Security Income recipients, who automatically receive the subsidy without applying.

Main Outcomes and Measures: Using survey assessments of cognition and numeracy from 2006-2010, we examined how cognitive abilities were associated with self-reported Part D enrollment, awareness of the LIS, and application for the LIS**.** We also compared out-of-pocket drug spending and premium costs between LIS-eligible beneficiaries who did and did not report receipt of the LIS. Analyses were adjusted for sociodemographic characteristics, household income and assets, health status, and presence of chronic conditions.

Results: Compared with LIS-eligible beneficiaries in the top quartile of cognition, those in the bottom quartile were significantly less likely to report Part D enrollment (adjusted rate, 63.5% vs. 52.0%; P=0.002), LIS awareness (58.3% vs. 33.3%; P=0.001), and LIS application (25.5% vs. 12.7%; P<0.001). Lower numeracy was also associated with lower rates of Part D enrollment (P=0.03) and LIS application (P=0.002). Reported receipt of the LIS was associated with significantly lower annual out-of-pocket drug spending (adjusted mean difference, −$256; P=0.02) and premium costs (−$273; P=0.02).

Conclusions and Relevance: Among Medicare beneficiaries likely eligible for the Part D LIS, poorer cognition and numeracy were associated with lower reported take-up. Current educational and outreach efforts encouraging LIS applications may not be sufficient for beneficiaries with limited abilities to process and respond to information. Additional policies may be needed to extend the financial protection conferred by the LIS to all eligible seniors.

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GLOSSARY

CMS ..... Centre for Medicare and Medicaid Services
HRS ..... Health and Retirement Study
LIS ..... Low Income Subsidy
MSP ..... Medicare Savings Program
SSA ..... Social Security Administration
SSI ..... Supplemental Security Income
VA ..... Veterans Administration

INTRODUCTION

Background

Medicare Part D prescription drug benefit plan was established as part of the Medicare Modernization Act of 2003, with coverage first beginning in January 2006. It offers Medicare beneficiaries access to prescription drug insurance through private plans that have been approved by the government. Medicare Part D enrollees with limited income and resources can qualify for a low-income subsidy (LIS) that provides premium and cost-sharing assistance to reduce out-of-pocket costs for prescription drugs. Medicare beneficiaries who also receive Medicaid, Medicare Savings Program (MSP), or Supplemental Security Income (SSI) benefits automatically receive the LIS. Others must apply and meet specific income and resource requirements to qualify.

Take up of Medicare Part D has been high. Only 7% of senior citizens lacked prescription drug insurance in 2006, compared with 24% in 2004.(1) However, take-up of the LIS has been remarkably low among those who are not automatically enrolled. Shoemaker and colleagues using the 2006 to 2007 Medicare Current Beneficiary Survey estimated that 41% of beneficiaries who were eligible for the LIS enrolled in it, the same proportion enrolled in Part D without the LIS and the remaining 18% did not have any drug coverage.(2) Sumner and colleagues estimated that only 40% of those eligible, but not automatically enrolled, applied for and received the LIS in 2009.(3)

The low take up of the LIS is surprising given the generous drug coverage offered by the LIS program. Many studies have shown the immense benefits that the LIS offers to enrollees. Duru and colleagues found that LIS enrollment was associated with a higher likelihood of clopidogrel adherence after stent placement, when compared to a propensity score matched group that was eligible but did not enroll in the LIS.(4) Other studies have documented lower rates of cost-related non-adherence among Part D enrollees enrolled in the LIS program.(5, 6) The low take-up rates is also surprising given efforts by the Social Security Administration (SSA) to enroll eligible beneficiaries.(7)

In this article, we examine the role that cognition, the general ability to understand and use information, and numeracy, the ability to work with numbers, play in the decision to enroll in the Medicare Part D LIS. How seniors decide whether to enroll in the Part D LIS is important because it provides information on the administration of the Part D program. In addition, the

managed competition framework of the Part D program is the basis of the health insurance exchanges that are part of the Patient Protection and Affordable Care Act of 2010. This framework relies on consumers to make efficient decisions about enrollment in plans and subsidies. An examination of the LIS provides an understanding of the factors that can lead consumers to deviate from rational decision-making.

Literature Review

Recent studies have questioned whether consumers have the acuity to make decisions that would make health insurance markets more efficient. Often consumers do not enroll in plans when it is in their best interest to enroll. McFadden and colleagues undertook a survey of older Americans examining their decision to enroll in Medicare Part D plans. They found that 8.4% of individuals failed to enroll in Part D plans in contradiction to their immediate self-interest given their high pharmacy bills.(8) Sinaiko and colleagues conducted a survey of enrollees in one unsubsidized plan offered through the Massachusetts health insurance exchange. They found that 30% of respondents reported incomes that would have made them eligible for a subsidized plan. The researchers conclude that while many respondents might have employers subsidizing their premiums and thus making the unsubsidized plan affordable, enrollment could also reflect confusion and sub-optimal choices, especially given that many of the respondents also reported dissatisfaction with plan affordability.(9)

When consumers do choose to enroll in insurance plans, they do not always select the plans that are the most aligned with their best interest. Sinaiko and Hirth examined employee plan choices among plans offered by employer when one of the plans was dominated. They found during their study period that one-third of workers were enrolled in the dominated plan.(10) Ericson and colleagues examined individuals who purchased unsubsidized insurance through the Massachusetts health insurance exchange from 2007 to 2009, they found that the majority of enrollees chose the least generous plan. They hypothesized that many were following a "choose the cheapest plan" heuristic, rather than comparing the plans to their specific situations.(11) Reid and colleagues performed a nationwide, cross-sectional analysis of beneficiaries enrolling in Medicare Advantage plans for the first time in 2011. They found that the market share of the plan explained most of the variation in plan choices (35.3%), outweighing the variation explained by premiums (25.7%), out of pocket expenses (11.6%) and quality ratings (11.6%).(12)

When researchers have examined choices in Part D plans, they've also found evidence of sub-optimal decision-making. Abaluck and Gruber examined claims data from Wolters Kluwer, which represents 31% of prescription drug claims filed in the United States. They matched these claims to Part D plan selections and found that consumers exhibited many behaviors that contradicted a rational model of decision-making. Consumers placed much more weight on plan premiums than they did on out of pocket expenses, they tended to value plan characteristics (e.g. donut hole coverage and cost sharing) far beyond the impact that these characteristics had on their own financial expenses and they showed low levels of risk aversion (13)

Heiss and colleagues looked at Medicare Part D enrollee decision making from 2006 to 2008. They found that fewer than 25% of individuals enrolled in plans that were *ex-ante* as good as the least cost plan available if they had used the Plan Finder tool made available to seniors by the Medicare administration.(14) Zhou and Zhang examining Part D plan selection in 2009, found that only 5.2% of beneficiaries chose the cheapest plan *ex-post*. Consumers were spending on average $368 more annually, than if they had purchased the plan that would have been the cheapest, given their consumption.(15)

Some research has shown that bad decision-making improves over time or when consumers are provided with appropriate information. Ketcham and colleagues analyzed a large dataset from a single insurer that sells Part D plans and administers plans sold by other companies. They found overspending dropped from 2006 to 2007, driven partly by consumers switching plans from 2006 to 2007 and also by convergence among expensive plans.(16) Kling and his colleagues found that when consumers received personalized cost information in the mail, they were more likely to switch to lower-cost plans. Even though this information could have been easily obtained on the Medicare plan finder website.(17)

Broadly, there are two main reasons why people make inefficient decisions in health insurance markets. The first is related to the way in which information is presented to consumers and the second is related to characteristics in consumers that might make it difficult for them to make optimal decisions. Regarding the former, exchanges often offer many choices and various plan characteristics. In 2016, Part D beneficiaries were choosing between 19 to 29 different plans depending on the region where they lived.(18) However, many choices increase the task complexity and cognitive load, and thus can result in making poor decision-making or

worse no decision at all.(19, 20) Researchers have found that large choice sets can lead to dissatisfaction among insurance purchasers. Bundorf and Szrek randomly assigned people to choose between prescription drug plans with choice set sizes varying from two to 16. Respondents were choosing between options, in which none of the plans were clearly superior. However, they found that as they increased choice set sizes, participants were more likely to express dissatisfaction with the number of options.(21)

In addition, through numerous hypothetical experiments, researchers have shown that when participants are provided more options, they are less likely to select the plan that would lower future cost, even when provided complete information on expected future healthcare expenditures.(22-25) Beyond experiments, studies of decision-making have shown that increasing the number option results in poor outcomes for consumers. Sinaiko and colleagues conducted a survey of enrollees in a plan offered through the Massachusetts health insurance exchange. They found that one-fifth of the respondents wished that they had less options to choose from.(9) McWilliams and colleagues using longitudinal survey data found enrollment in Medicare Advantage was unchanged or decreased, in regions where beneficiaries chose from larger number of plans.(26)

The second reason why consumers make inefficient decisions is specific to individuals. Classic economic theory assumes that individuals know what is best for them because they are able to calculate the cost and benefits of each decision. It also assumes that people have focus and willpower, and are thus able to implement what is in their best interest.(27) However, poor cognition or numeracy can hamper the ability of individuals to behave like rational actors.

Cognition refers to one's capacity to understand and use information. It is multifaceted and includes memory, verbal ability and spatial ability.(28) Research evidence shows that lower cognition can lead to poor decision making in the health insurance market. Winter and colleagues performed a survey of the Medicare population before enrollment into Part D programs began. They found that lack of information about Medicare Part D programs was high among those with lower cognition.(29) Levy and Weir examined enrollment in Part D programs using a longitudinal survey and they found that those who had not enrolled had lower cognition.(1) There's also evidence that lower cognition impacts other health insurance markets. Using a longitudinal survey, Chan and Elbel found that among Medicare patients, those in the lower third of cognition were less likely to enroll in Medicare supplemental

insurance plans.(28) McWilliams and colleagues found that adults with lower cognitive functions were less responsive to the generosity of benefits than those with higher cognitive functions when choosing Medicare Advantage plans over traditional Medicare plans.(30)

Numeracy has been defined as the ability to use basic probability and mathematical concepts.(31) Numeracy is important in electing a healthcare plan, as this process requires determining expected health care needs and estimating expected expenses under various plans. Researchers have found that low numeracy results in less optimal decisions when choosing health insurance plans in various experiments. Greene and colleagues conducted a study in which adults viewed information about a hypothetical consumer-directed health plan and then completed a survey that gauged comprehension. Less numerate participants understood less about the plan.(32) Wood and colleagues asked participant to select the plan that would minimize costs for a hypothetical individual based on information given. Participants with higher numeracy were more likely to select the correct plan.(33) In a similar study, Hanoch and colleagues conducted an experiment in which highly numerate medical students and residents were provided with information on drug plans and asked to advise hypothetical patients to choose the best plan based on their specific concerns. Even among this population, high numeracy was associated with correct responses.(34) Chan and Elbel using a longitudinal survey found that participants with lower numeracy were less likely to enroll in a supplemental Medicare insurance plan.(28)

The relationship between cognition and take-up of the LIS, has not been directly examined. One prior study, listed above, found cognition to be correlated with Part D enrollment, but did not assess this relationship among beneficiaries eligible for more generous Part D benefits through the LIS.(1) No prior study has examined determinants of subsidy application by eligible seniors already enrolled in Part D, among whom the lack of LIS take-up is concentrated.(35)

If low take-up of the LIS is related to the cognitive abilities of eligible beneficiaries, outreach and educational efforts may be insufficient to effectively extend the program's benefits to vulnerable subgroups of low-income seniors. To assess the potential need for alternative policy strategies, we used data from the Health and Retirement Study (HRS) to examine determinants of Part D enrollment, awareness of the LIS, and application for the LIS among beneficiaries likely eligible for the subsidy but not automatically receiving it. We also compared

out-of-pocket drug spending and premium costs between those receiving and not receiving the subsidy. Part of this work has been previously published.(36)

METHODS

Study Population

We analyzed data from the 2006, 2008, and 2010 waves of the HRS, a nationally representative, longitudinal survey of adults over age 50 in the continental United States conducted in English or Spanish.(37) Our analyses included elderly participants reporting enrollment in Medicare who were likely eligible for the LIS based on detailed reports of household income and assets and program rules governing eligibility thresholds (Appendix). Our determinations of LIS eligibility produced estimates (28-29% of all Medicare beneficiaries in the HRS from 2006-2010) that closely matched estimates reported by the Centers for Medicare and Medicaid Services (CMS) over these years.(38-40) We focused our analyses on beneficiaries with particularly limited means who were accordingly eligible for a full rather than partial subsidy, as these beneficiaries had the greatest incentive to enroll in Part D and apply for the LIS. In 2010, for example, beneficiaries were eligible for a full subsidy if their applicable household income was less than 135% of the federal poverty level and their assets were less than $6,600 if single or $9,910 if married.

For each survey year, we classified participants as qualifying automatically for the LIS if they reported receiving SSI in the prior year or having concurrent Medicaid coverage, and excluded these participants from all but descriptive analyses. In addition, we excluded Medicare beneficiaries reporting enrollment in a health maintenance organization plan because they were not consistently asked questions about Part D and the LIS. For analyses of Part D enrollment, we also excluded those reporting employer-sponsored or Veterans Administration (VA) health benefits, because Part D and the LIS may not offer significant advantages to some beneficiaries with these sources of supplemental coverage. We conducted a sensitivity analysis excluding all veterans. The Harvard Medical School Committee on Human Studies approved our study protocol.

Study Variables

Part D Enrollment and LIS Awareness, Application, and Receipt

We measured enrollment in Part D, awareness of the LIS, application for the LIS, and receipt of the LIS from self-reports. Specifically, participants reporting enrollment in Part D were asked, "Medicare beneficiaries with limited income and resources may qualify to get extra

help paying for their prescription drug coverage. Did you know about this program?" Those who responded affirmatively were asked, "Did you apply for extra help?" Those who reported applying were asked, "Was your application for extra help accepted or denied?" Awareness of the LIS was assessed only in the 2008 and 2010 surveys. We assumed those who were unaware of the subsidy in these years did not apply or receive it. In 2006, LIS application and receipt were assessed for all Part D enrollees in our study sample.

Out-of-pocket Drug Spending and Premium Costs

All Part D enrollees were asked to report their monthly premiums for prescription drug plans. Part D enrollees who reported regularly taking prescription drugs were also asked to report their monthly out-of-pocket spending on prescription drugs in the prior year. We annualized these monthly estimates.

Cognition and Numeracy

Take-up of the LIS by eligible beneficiaries who must apply requires awareness of the program, understanding of LIS requirements, recognition of the value of subsidies for which they might qualify, and the ability to navigate the application process through the SSA or their state Medicaid office. We used two measures to assess participants' cognitive capacities for executing these functions – a measure of cognition and a more specific measure of numeracy.(28, 33, 41, 42)

To assess cognition, the HRS uses a validated survey instrument modeled after the Telephone Interview for Cognitive Status, an adaptation of the Mini-Mental State Exam for use over the telephone.(43-45) Participants were asked to complete a series of tasks assessing orientation, attention, memory, word recognition and comprehension, and ability to count and perform simple arithmetic. Summary cognition scores could range from 0 (no tasks completed correctly) to 35 (all tasks completed correctly). Participants were also asked to perform 3 mathematical tasks testing participants' numeracy – the ability to work with numbers and probabilities.(44) The numeracy questions were adapted from an abbreviated 3-item scale that measures global numeracy with similar reliability as an expanded scale with more items.(46) As stated in the introduction, we analyzed numeracy in addition to cognition because it measures distinct cognitive skills that independently predict insurance decisions made by Medicare beneficiaries.(28, 33, 41, 42)

Cognition and numeracy could not be measured for participants who required proxy respondents, 72% of whom did not complete surveys because of cognitive impairments.

Covariates

From survey data, we determined participants' age, sex, race, ethnicity, health status, chronic conditions, depressive symptoms, and difficulties with activities of daily living (ADLs). Participants reported their race and ethnicity based on categories specified by HRS investigators; we included this information in the analysis because LIS application and Part D enrollment differed by race and ethnicity. We classified participants as depressed if they reported depressive symptoms in response to half or more of questions included in an abridged version of the Center for Epidemiologic Studies–Depression questionnaire.(47) ADLs included walking across a room, getting in and out of bed, dressing, bathing, and eating.

Statistical Analysis

For each dependent variable and corresponding sample (Table 1), we estimated logistic regression models predicting Part D enrollment, awareness of the LIS, and application to the LIS as a function of cognition or numeracy and all covariates described above. We included cognition and numeracy as explanatory variables in separate models to allow generalization of results to settings in which information on only one of these related variables is available. We also estimated models that included both cognition and numeracy (Appendix).

For tests of overall association with dependent variables, we specified cognition (range 0-35) and numeracy (0-3) scores as continuous variables in models. To facilitate interpretation of results, we also present mean adjusted Part D enrollment, LIS awareness, and application rates by quartile of cognition scores and by the number of correctly completed questions assessing numeracy.

In addition, to assess the benefits of receiving the LIS among eligible Part D enrollees who did not automatically receive it, we compared out-of-pocket drug spending and premium costs between those receiving and those not receiving the LIS. Using linear regression models, we adjusted these comparisons for cognition, numeracy, and covariates.

We used robust design-based variance estimators to account for geographic clustering and repeated measures when estimating 95% confidence intervals (CIs) and determining statistical significance.(48) We did not employ sampling weights in analyses because they were

not available for nursing home residents, among whom cognitive impairment is prevalent and prescription drug needs are high. All statistical analyses were conducted with Stata version 12 (StataCorp, College Station, TX).

RESULTS

Sample sizes after exclusions are reported in Table 1. Lack of cognition and numeracy scores for participants with proxy respondents explained most exclusions due to missing data.

Descriptive Comparisons

Results of unadjusted comparisons of sociodemographic and clinical characteristics are presented in Table 2. Among Medicare beneficiaries likely eligible for the LIS but not automatically receiving it (hereafter the target population), 42.2% were not enrolled in Part D. Those who did not enroll were older, had poorer cognition and numeracy, were less likely to use prescription drugs regularly, were in better health, had fewer chronic conditions, were more likely to be veterans, and were less likely to be depressed and female.

Among Part D enrollees in the target population, many of the same differences were observed between those who reported applying and those who reported not applying for the subsidy, but differences in prescription drug use and health-related variables were smaller and often not statistically significant (Table 2). In addition, Part D enrollees who reported not applying for the LIS were less likely to be white and had fewer years of education.

Enrollment in Part D among LIS-eligible Beneficiaries

Among participants in the target population, enrollment in Part D (Table 3) was more likely to be reported by those with higher cognition scores (adjusted odds ratio (OR), 1.03 for an additional correctly completed task; 95% CI, 1.00 to 1.05; P=0.02) and higher numeracy scores (OR, 1.21; 95% CI, 1.03 to 1.44; P=0.03). As displayed in the Figure, adjusted rates of reported Part D enrollment ranged from 52.0% (95% CI, 47.5% to 56.4%) for those in the lowest quartile of cognition to 63.5% (95% CI, 58.7% to 68.2%) for those in the highest quartile, and from 55.1% (95% CI, 52.4% to 57.8%) for those completing no numeracy tasks correctly to 62.1% (95% CI, 55.1% to 69.1%) for those completing 2-3 tasks. Additional explanatory variables associated with lower rates of enrollment in Part D included older age, Hispanic ethnicity, veteran status, and not having hypertension (Table 3). In a sensitivity analysis excluding all veterans, estimates for cognition and numeracy were not substantively changed.

Awareness of LIS among Eligible Part D Enrollees

Among Part D enrollees in the target population, awareness of the LIS (Table 3) was more likely to be reported by those with higher cognition scores (OR, 1.06; 95% CI, 1.03 to 1.09; P<0.001) but not those with higher numeracy scores (OR, 1.20, 95% CI, 0.99 to 1.45; P=0.06). Adjusted rates of LIS awareness in this group ranged from 33.3% (95% CI, 23.1% to 43.6%) for those in the lowest quartile of cognition to 58.3% (95% CI, 50.2% to 66.4%) for those in the highest quartile (Figure). Older age, male sex, and non-Hispanic black race also were associated with significantly lower awareness of the LIS (Table 3).

Application for the LIS among Eligible Part D Enrollees

Among Part D enrollees in the target population, application for the LIS was more likely to be reported by those with higher cognition scores (OR, 1.05; 95% CI, 1.03 to 1.08; P<0.001) and higher numeracy scores (OR, 1.31; 95% CI, 1.09 to 1.57; P=0.002). Adjusted rates of reported LIS application ranged from 12.7% (95% CI, 8.5% to 16.9%) for those in the lowest quartile of cognition to 25.5% (95% CI, 20.0% to 31.1%) for those in the highest quartile, and from 19.4% (95% CI, 16.0% to 22.7%) for those completing no numeracy tasks correctly to 30.2% (95% CI, 21.4% to 39.1%) for those completing 2-3 tasks (Figure). In addition, older age, more assets, and absence of arthritis were associated with lower rates of reported LIS application (Table 3).

Among participants with proxy respondents, adjusted rates of Part D enrollment (62.0%; 95% CI, 56.5% to 67.5%), LIS awareness (55.4%; 95% CI, 42.4% to 68.4%), and LIS application (16.4%; 9.4% to 23.4%) were imprecisely estimated but generally similar to rates reported by participants in the top 2 or 3 quartiles of cognition scores.

Out-of-pocket Costs Associated with LIS Receipt

Among Part D enrollees in the target population, self-reported receipt of the LIS was associated with significantly lower annual out-of-pocket drug spending (adjusted mean difference: −$256; P=0.02) and premium costs (−$273; P=0.02).

DISCUSSIONS, CONCLUSION AND SUGGESTIONS FOR FUTURE WORK

Discussion and Conclusion

In this nationally representative study of low-income Medicare beneficiaries who were likely eligible for the LIS but did not automatically qualify, many reported not enrolling in Part D, and many of those who did enroll in Part D reported that they were unaware of the subsidy or did not apply for it. Older age, poorer cognition, and poorer numeracy strongly and consistently predicted these apparent failures to take up fully subsidized drug benefits. Those who reported receiving the subsidy had substantially lower out-of-pocket drug spending and premium costs, suggesting deleterious financial consequences for seniors who were unable to recognize or apply for these benefits.

These findings are consistent with previous research suggesting that most seniors who would benefit financially from Part D drug coverage enroll in the program, but that a substantial minority does not, particularly those with low incomes and less education.(1, 8, 49) Our findings are also consistent with prior studies demonstrating low awareness and take-up of the LIS among eligible beneficiaries and lower out-of-pocket drug spending among those who receive it.(5)(5, 6, 50, 51) Our study further suggests that outreach efforts by the SSA to enroll eligible beneficiaries in the subsidy program have been less effective for beneficiaries with limited cognitive abilities. Thus, alternative strategies may be necessary to extend the financial and potential clinical benefits of the subsidy to eligible seniors who lack the mental capacity necessary to respond to educational materials and apply.

One solution is to change the LIS from an opt-in to an opt-out program for eligible beneficiaries who are not already automatically enrolled.(3, 52) The SSA and CMS, however, are not permitted to use tax records from the Internal Revenue Service to reliably identify eligible beneficiaries.(7) Additional legislation would be needed to authorize use of tax information for this purpose. The SSA could automatically enroll beneficiaries who have been deemed potentially eligible for the subsidy from other federal sources of financial data; these potentially eligible beneficiaries already receive subsidy applications from the SSA as part of its outreach efforts. This alternative strategy, however, would substantially expand the population intended to receive the LIS and would therefore require additional financing.

To supplement outreach efforts by the SSA, the CMS could provide incentives to Part D plans to collect the information necessary to determine LIS eligibility for enrollees each year.

Medicare Advantage prescription drug (MA-PD) plans may already have an incentive to ensure eligible enrollees are receiving the LIS, as more generous drug coverage may lower non-drug costs for which MA-PD plans bear greater risk.(30, 53-57) Whether plans would be more successful than the SSA in facilitating subsidy applications from cognitively impaired seniors is unclear. Absent a comprehensive solution, provisions in the 2010 Accountable Care Act to close the coverage gap or "doughnut hole" in the standard Part D benefit may help extend some of the LIS benefits to eligible seniors who fail to apply.

More generally, our findings contribute to growing evidence of suboptimal enrollment decisions by elderly Medicare beneficiaries.(8, 13, 26, 28, 33, 49) This evidence suggests policies that rely on seniors' choices to support efficient competition among plans may be less effective when not coupled with government efforts to regulate choice sets and guide beneficiaries to the best available options. Even when presented with a single dominant option in the form of free additional drug coverage, many low-income seniors are apparently unable to choose this option.(3) Thus, in concert with previous research, our finding of lower LIS take-up by seniors with impaired abilities to recognize, process, or respond to information suggests that simply providing more information to Medicare beneficiaries about insurance options may not optimize their enrollment decisions.

Our study had several limitations, the most important of which was our reliance on self-reported data. Rates of LIS application and receipt reported by HRS participants were substantially lower than rates reported by the CMS.(1) Self-reported awareness of the LIS, however, was similar to awareness in another national survey in which a higher percentage of low-income beneficiaries reported receipt of the subsidy, and in which awareness was strongly associated with receipt.(51) In addition, Part D enrollment reported by traditional fee-for-service Medicare beneficiaries in the HRS (42%) approximated national estimates from administrative data, and cognition was consistently associated with self-reported Part D enrollment, LIS awareness, and LIS application.(58) Moreover, the strong association between reported LIS receipt and out-of-pocket drug spending suggests that self-reports reliably predicted LIS application and participation.

In addition, assessments of cognition and numeracy were missing for participants who required proxies to complete surveys on their behalf. Because participants with proxies may have had help in making insurance decisions, our results may overstate the importance of

cognitive abilities for LIS take-up by beneficiaries with strong social supports. Finally, we were unable to assess effects of the LIS on clinical outcomes.

Nevertheless, our findings suggest low-income Medicare beneficiaries with poor cognitive skills are more likely to forgo subsidized drug benefits for which they are eligible and about which they are informed. Additional policies are needed to extend the financial protection afforded by the LIS to vulnerable groups for whom it is intended to help.

Suggestions for future work

There are a number of avenues for future research. The first would be further analysis that does not rely upon self-reported data. Medicare Part D claims data could be used to more precisely estimate out of pocket expenditure and to determine actual enrollment in the LIS. This data set can be linked to the HRS, which has conducted assessments of cognition and numeracy. Alternatively, researchers could independently assess cognition and numeracy on a randomly derived sample. The second area of further research would be additional exploration of some of the secondary results within our findings. For example, we found that among those eligible for the LIS, Hispanic ethnicity was associated with a lower likelihood of applying for Part D. This could indicate the presence of language barriers that makes it difficult for those who do not speak English to access the resources of Medicare. Finally, the impact of cognition and numeracy should be studied in other healthcare markets. The recent establishment of federal and state health insurance exchanges provides an opportunity to see if those with lower cognition and numeracy are making suboptimal decisions. If this is the case, then there is an opportunity to create initiatives in order to provide these individuals with additional support.

SUMMARY

The take-up of the Medicare Part D LIS by eligible beneficiaries has been low despite the attractive drug coverage it offers and outreach efforts by the SSA. We use a nationally representative study of low-income Medicare beneficiaries who were likely eligible for the LIS, but did not automatically qualify, in order to examine the role of cognitive abilities in the low take-up of the LIS. We found that poorer cognition and poorer numeracy strongly and consistently predicted the failure to apply for the LIS. In addition, those who reported receiving the subsidy had lower out-of-pocket drug spending and premium cost. Our results are consistent with previous research that shows that poor cognitive abilities predict sub-optimal decisions in healthcare markets. Broadly, this suggests that healthcare policies that rely on consumer choices to make efficient decisions may be less effective if not coupled with government efforts to regulate choice sets and guide beneficiaries to the best available options.

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TABLES AND FIGURES

Figure

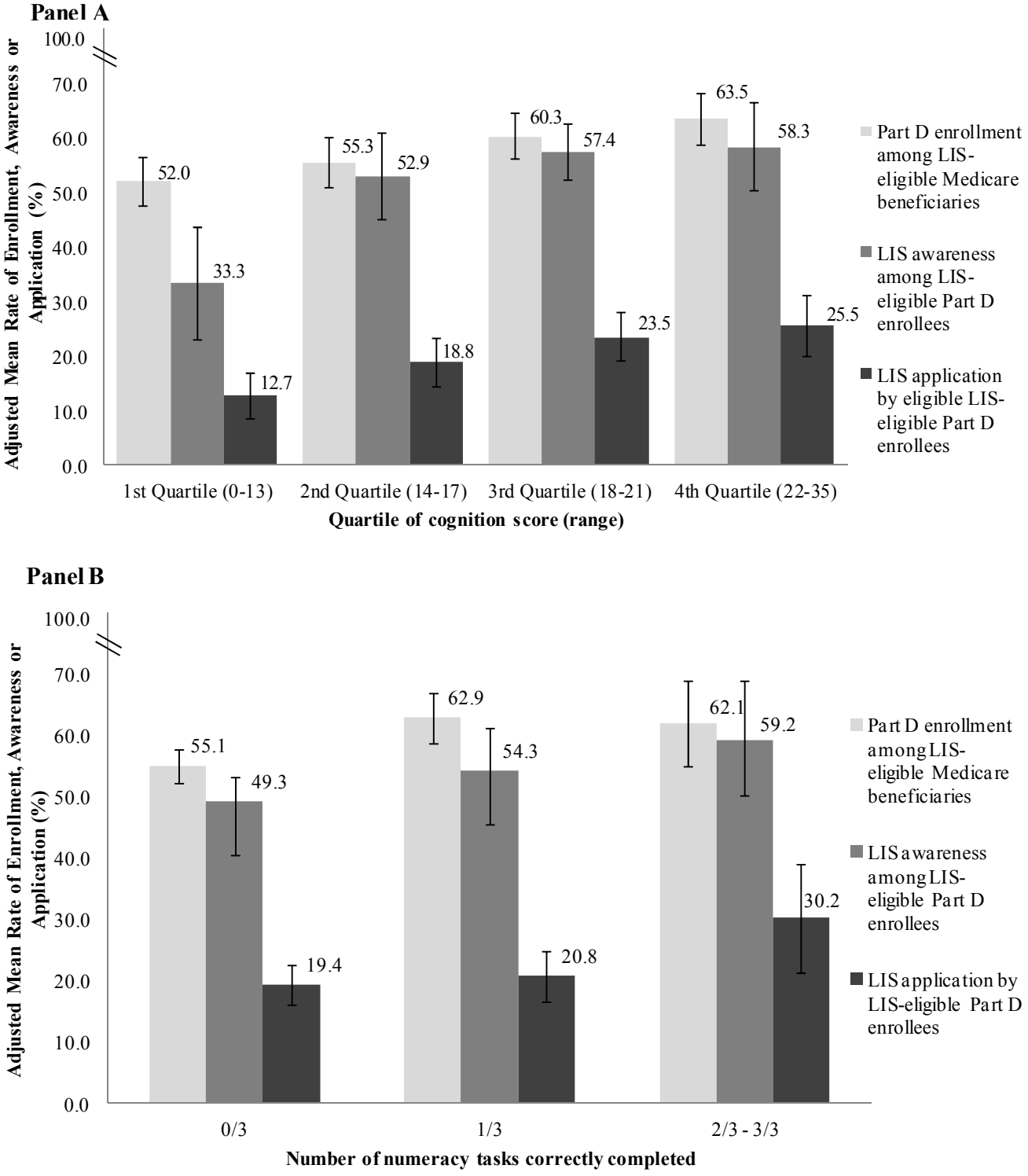

Figure. Adjusted rates of Part D enrollment, LIS awareness, and LIS application by A) cognition and B) numeracy.

Table 1: Inclusion criteria and sample sizes for each dependent variable

Inclusion criteria and corresponding sample size (person-years of survey data)	**Dependent variable**		
	Part D enrollment (assessed in 2006, 2008 and 2010)	**Awareness of the LIS** (assessed in 2008 and 2010 only)	**Application for the LIS** (assessed in 2006, 2008 and 2010)
Medicare beneficiaries age 65 or older residing in the U.S.	32,036	21,084	32,036
Not in a Medicare HMO	24,722	15,884	24,722
Likely eligible for the full subsidy	5,789	3,679	5,789
Likely eligible for the full subsidy but would have to apply	3,136	2,000	3,136
Not receiving employer sponsored insurance	2,584	criterion not applied	criterion not applied
Not receiving VA health benefits	2,466	criterion not applied	criterion not applied
Enrolled in Part D	criterion not applied	996	1,580
Participant (not proxy) responded	2215	899	1426
No missing data on analytic variables	2206	845	1,350

Table 2. Sociodemographic and Clinical Characteristics of Comparison Groups

Characteristic	Automatically qualified for LIS (n = 2653)	Medicare beneficiaries eligible for LIS but must apply			Part D enrollees eligible for LIS but must apply		
		Not Enrolled in Part D (n=931)	Enrolled in Part D (n=1275)	P-value for test vs. not enrolled	Did not Apply (n=1045)	Applied to LIS (n=305)	P value for test vs. did not apply
Mean age (years)	76.6	77.4	75.9	0.001	76.4	74.1	<0.001
Female (%)	70.2	63.1	72.4	<0.001	70.2	79.1	0.01
Race/Ethnicity				0.77			0.03
Non-Hispanic white (%)	42.3	53.0	55.0		53.6	63.7	
Non-Hispanic black (%)	28.4	28.8	27.5		28.3	24.3	
Hispanic (%)	25.4	15.6	15.3		15.9	10.2	
Other (%)	3.9	2.5	2.1		2.2	1.8	
Mean educational attainment (years)	8.9	10.0	9.8	0.10	9.7	10.5	0.002
Married (%)	28.0	31.2	31.5	0.91	32.1	32.6	0.89
Military veteran (%)	10.4	17.9	7.9	<0.001	9.4	6.5	0.05
Household income and assets[a]							
Mean countable income ($)	$12,187.46	$11,620.78	$12,086.99	0.06	$12,167.54	$ 12,557.04	0.24
Mean countable assets ($)	$25,417.73	-$2,605.94	-$3,634.58	0.20	-$2,523.47	-$6,782.73	0.16
Mean cognition score (0 worst - 35 best)	17.1	17.3	18.2	<0.001	17.8	19.9	<0.001
Quartile of cognition score (%)				<0.001			<0.001
Lowest quartile (0-13)	25.7	24.7	18.9		21.4	9.5	
Quartile 2 (14-17)	24.0	26.4	23.3		24.4	19.3	
Quartile 3 (18-21)	26.9	25.5	28.7		27.6	32.5	
Highest quartile (22-35)	23.4	23.4	29.1		26.6	38.7	
Mean numeracy score (0 worst - 3 best)	0.5	0.5	0.6	0.05	0.6	0.7	0.007

Number of numeracy items completed correctly (%)				0.04			0.01
0/3	62.3	59.7	54.0		55.9	46.9	
1/3	28.0	28.5	33.4		33.3	34.7	
2-3/3	9.7	11.8	12.6		10.8	18.4	
Regular use of prescription drugs (%)	93.2	80.4	90.9	<0.001	89.8	93.2	0.14
Depression based on CESD scale[b] (%)	29.1	21.9	26.1	0.002	25.5	28.3	0.22
Mean self-reported health (1 excellent, 5 poor)	3.7	3.4	3.5	0.001	3.5	3.5	0.50
Some difficulties on two or more ADLs[c] (%)	35.8	20.3	20.1	0.93	19.8	17.5	0.27
Self-reported chronic conditions (%)							
Hypertension	76.2	66.1	75.6	0.001	74.6	79.7	0.20
Diabetes	34.9	24.3	32.1	0.002	29.5	35.4	0.10
Cancer, except skin cancer	17.0	15.9	16.3	0.84	15.7	19.7	0.08
COPD	18.8	11.7	16.9	0.001	16.0	19.7	0.17
Coronary heart disease or other heart problems.	39.3	32.9	34.1	0.53	34.2	36.6	0.33
Stroke	19.2	15.1	13.5	0.37	13.8	12.0	0.42
Psychiatric problems	34.1	19.2	24.0	0.002	23.1	25.8	0.26
Arthritis or rheumatism	76.9	68.9	76.4	0.002	74.4	83.7	0.001
Mean number of chronic conditions	3.2	2.5	2.9	<0.001	2.8	3.1	0.002

COPD = Chronic Obstructive Pulmonary Disease, CESD= Center for Epidemiological Studies-Depression, ADLs = Activities of Daily Living.

All estimates are adjusted for the complex design of the survey. Chi-square tests were used to compare distributions of categorical variables and significance tests for continuous variables were performed with an adjusted Wald test (approximate F statistic). Because of rounding, percentages may not total 100.

[a] Countable income and assets refer to the income and assets that are counted towards the LIS eligibility once all exclusions have been applied

[b] We considered participants to be depressed if they reported depressive symptoms in response to half or more of questions included in an abridged version of the Center for Epidemiologic Studies–Depression questionnaire.

[c] Activities of daily living include bathing, dressing, eating, getting in and out of bed, and walking across a room

Table 3. Results of logistic regression models predicting A) Part D enrollment, B) LIS awareness, and C) LIS application

	(A)	(B)	(C)
	Part D enrollment among LIS-eligible beneficiaries OR (95% CI)	**LIS awareness among eligible Part D enrollees** OR (95% CI)	**LIS application among eligible Part D enrollees** OR (95% CI)
Year			
2006	-		-
2008	0.88 (0.71 - 1.09)	-	1.21 (0.88 - 1.65)
2010	0.73** (0.54 - 0.98)	0.92 (0.69 - 1.22)	1.33* (0.99 - 1.79)
Age	0.98** (0.97 - 1.00)	0.97** (0.95 - 1.00)	0.96*** (0.94 - 0.98)
Female	1.25* (0.97 - 1.61)	1.77*** (1.16 - 2.71)	1.51* (0.99 - 2.31)
Race/Ethnicity			
Non-Hispanic white	-	-	-
Non-Hispanic black	0.85 (0.62 - 1.17)	0.62*** (0.45 - 0.86)	0.74 (0.51 - 1.08)
Hispanic	0.71** (0.53 - 0.96)	0.48* (0.20 - 1.12)	0.52 (0.23 - 1.19)
Other	0.98 (0.48 - 2.00)	0.85 (0.37 - 1.92)	1.01 (0.37 - 2.75)
Educational attainment (years)	0.97* (0.94 - 1.00)	1.03 (0.99 - 1.07)	1.00 (0.94 - 1.07)
Married	1.11 (0.81 - 1.51)	0.98 (0.67 - 1.42)	1.24 (0.91 - 1.69)
Military veteran	0.45*** (0.31 - 0.65)	1.06 (0.61 - 1.86)	0.81 (0.43 - 1.51)
Household income and assets/ $10,000[a]			
Mean countable income	1.16 (0.96 - 1.39)	1.33* (0.97 - 1.83)	1.00 (0.74 - 1.35)
Mean countable assets	0.97 (0.93 - 1.01)	0.94 (0.82 - 1.07)	0.83** (0.69 - 1.00)
Cognition score (0 worst – 35 best)	1.03** (1.00 - 1.05)	1.06*** (1.03 - 1.09)	1.05*** (1.03 - 1.08)
Numeracy score (0 worst – 3 best)[b]	1.21** (1.03 - 1.44)	1.20* (0.99 - 1.45)	1.31*** (1.09 - 1.57)
Depressed based on CESD scale[c]	1.12 (0.91 - 1.38)	1.13 (0.78 - 1.63)	1.20 (0.90 - 1.61)
Some difficulties on ≥2 ADLs[d]	1.01 (0.77 - 1.34)	1.15 (0.75 - 1.76)	0.87 (0.57 - 1.31)
Self-reported chronic conditions			
Hypertension	1.59*** (1.24 - 2.03)	0.96 (0.65 - 1.44)	1.36 (0.82 - 2.26)
Diabetes	1.28* (0.99 - 1.65)	0.98 (0.66 - 1.44)	1.20 (0.84 - 1.70)
Any cancer, except skin cancer	1.03 (0.74 - 1.42)	1.19 (0.79 - 1.78)	1.43* (0.99 - 2.05)
COPD	1.27* (0.98 - 1.65)	0.91 (0.55 - 1.51)	1.04 (0.68 - 1.60)
Coronary heart disease or other heart problems	0.94 (0.78 - 1.14)	1.18 (0.81 - 1.71)	1.03 (0.78 - 1.36)
Stroke	0.88 (0.65 - 1.20)	1.06 (0.63 - 1.79)	0.89 (0.53 - 1.49)
Psychiatric problems	1.12 (0.88 - 1.43)	0.76 (0.53 - 1.08)	0.89 (0.63 - 1.26)
Arthritis or rheumatism	1.18 (0.90 - 1.54)	1.25 (0.83 - 1.87)	1.61** (1.03 - 2.50)

COPD = Chronic Obstructive Pulmonary Disease, CESD= Center for Epidemiological Studies-Depression, ADLs = Activities of Daily Living.

[a] Countable income and assets refer to the income and assets that are counted towards the LIS eligibility once all exclusions have been applied (see Appendix for more details).

[b] Results from a separate regression with the same covariates except cognition.

[c] We considered participants to be depressed if they reported depressive symptoms in response to half or more of questions included in an abridged version of the Center for Epidemiologic Studies–Depression questionnaire.

[d] Activities of daily living include bathing, dressing, eating, getting in and out of bed, and walking across a room.

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

APPENDIX

Determining LIS Eligibility

We followed eligibility criteria for the LIS published by the Social Security Administration.[i] Individuals automatically qualify if they are receiving Supplemental Security Income, full Medicaid benefits, or benefits from the Medicare Savings Program (MSP) as a Qualified Medicare Beneficiary, Specified Low-Income Medicare Beneficiary, or Qualified Individual. We classified HRS respondents as automatically qualified if they reported SSI income during the previous calendar year or concurrent Medicaid coverage. Because the HRS does not collect information on receipt of MSP enrollment, we could not identify and classify recipients of MSP benefits as automatically qualifying for the LIS.

Other Medicare beneficiaries who meet certain income and resource criteria are also eligible for the subsidy but they must first apply. Beneficiaries with household incomes at or below 135% of the Federal Poverty Level (FPL) are potentially eligible for the full subsidy. Those whose household incomes are at or below 150% of the FPL but above 135% of the FPL are potentially eligible for a partial subsidy. Income of spouses is included in determinations, and household income is applied to different FPLs based on marital status and household size. Both earned and unearned income are considered in LIS eligibility determinations and are subject to different exclusions. Earned income includes wages, net earnings from self-employment, payments for services in a sheltered workshop, royalties, and honoraria.[ii] In calculating earned income, we added the respondent's and spouse's (if married) wages from labor and self-employment. We were able to apply most of the key legislated exclusions (e.g. the first $65 per month of earned income) in determining earned income subject to LIS eligibility thresholds.[iii] Exclusions to earned income we could not make because of data limitations included tax refunds and exclusions related to blindness.

To estimate respondents' unearned household income that would be considered in LIS eligibility determinations, we summed respondents' and spouses' (if married) income from SSI, Social Security Disability Insurance, pensions and annuities, veteran benefits, rental income, and any other miscellaneous source of unearned income.[iv,v] We applied the $20 per month general income exclusion to respondents' unearned income, following LIS eligibility rules, but could not apply other exclusions due to data limitations.[vi] We then summed earned and

unearned income amounts, except applicable exclusions, and compared these amounts to the FPL corresponding to each respondent's marital status and household size and the calendar year of the survey.

Means testing for the LIS also includes an assessment of assets. Assets that are considered in LIS eligibility determinations, or countable resources, include stock, bonds, annuities, financial institution accounts, mortgage fund shares, retirement accounts, promissory notes, life insurance policies, trusts, and the equity value of real estate excluding primary residence. The detailed questions about assets in the HRS allowed us to estimate respondents' countable resources by summing the self-reported net value of their assets in almost all of these specific categories.[vii] Per LIS rules, we subtracted $3000 from respondents' totals if married and $1500 if single as a resource exclusion to cover burial costs. We could not apply other exclusions to countable resources, but these were relatively minor.[viii]

Numeracy Questions

1. If the chance of getting a disease is 10 percent, how many people out of 1,000 would be expected to get the disease?
2. If 5 people all have the winning numbers in the lottery and the prize is two million dollars, how much will each of them get?
3. Let's say you have $200 in a savings account. The account earns 10 percent interest per year. How much would you have in the account at the end of two years?

[i] HI 03020.000 – HI 03030.025 https://secure.ssa.gov/poms.nsf/lnx/0603020000, Accessed 1 September, 2012
[ii] HI 03020.020 https://secure.ssa.gov/poms.nsf/lnx/0603020020 Accessed 1 September, 2012
[iii] HI 03020.030 https://secure.ssa.gov/poms.nsf/lnx/0603020030 Accessed 1 September, 2012
[iv] HI 03020.035 https://secure.ssa.gov/poms.nsf/lnx/0603020035 Accessed 1 September, 2012
[v] HI 03020.040 https://secure.ssa.gov/poms.nsf/lnx/0603020040 Accessed 1 September, 2012
[vi] HI 03020.050 https://secure.ssa.gov/poms.nsf/lnx/0603020050 Accessed 1 September, 2012
[vii] HI 03030.001 https://secure.ssa.gov/poms.nsf/lnx/0603030001 Accessed 1 September, 2012
[viiiviii] HI 03030.020 https://secure.ssa.gov/poms.nsf/lnx/0603030020 Accessed 1 September, 2012

Appendix Tables

In Appendix Tables 1-3, we provide full regression results for 5 different model specifications: 1) cognition specified as a continuous score, numeracy not included; 2) cognition specified as a categorical variable by quartile, numeracy not included; 3) numeracy specified as a continuous score, cognition not included; 4) numeracy specified as a binary variable, cognition not included; 5) both cognition and numeracy included as continuous scores.

Appendix Table 1: Results from logistic regression predicting Part D enrollment among LIS-eligible Medicare beneficiaries

	(1) **Cognition score** OR (95% CI)	(2) **Cognition in quartiles** OR (95% CI)	(3) **Numeracy score** OR (95% CI)	(4) **Numeracy in categories** OR (95% CI)	(5) **Cognition score and numeracy score** OR (95% CI)
Year					
2006	-	-	-	-	-
2008	0.88	1.00	0.88	0.88	0.88
	(0.71 - 1.09)	(1.00 - 1.00)	(0.71 - 1.09)	(0.71 - 1.09)	(0.72 - 1.09)
2010	0.73**	0.87	0.72**	0.72**	0.73**
	(0.54 - 0.98)	(0.70 - 1.08)	(0.53 - 0.98)	(0.53 - 0.97)	(0.54 - 0.98)
Age	0.98**	0.73**	0.98***	0.98***	0.98**
	(0.97 - 1.00)	(0.54 - 0.99)	(0.96 - 0.99)	(0.96 - 0.99)	(0.97 - 1.00)
Female	1.25*	0.98**	1.36**	1.36**	1.31**
Race/Ethnicity	(0.97 - 1.61)	(0.97 - 1.00)	(1.04 - 1.77)	(1.04 - 1.78)	(1.02 - 1.69)
Non-Hispanic white	-	1.24*	-	-	-
		(0.96 - 1.60)			
Non-Hispanic black	0.85	0.87	0.83	0.84	0.87
	(0.62 - 1.17)	(0.64 - 1.18)	(0.62 - 1.12)	(0.63 - 1.13)	(0.63 - 1.19)
Hispanic	0.71**	0.72**	0.74*	0.75*	0.72**
	(0.53 - 0.96)	(0.53 - 0.97)	(0.54 - 1.01)	(0.55 - 1.02)	(0.53 - 0.99)
Other	0.98	0.97	0.96	0.96	0.98
	(0.48 - 2.00)	(0.47 - 2.00)	(0.47 - 1.96)	(0.46 - 1.98)	(0.48 - 2.04)
Educational attainment	0.97*	0.97**	0.97*	0.97*	0.96**
	(0.94 - 1.00)	(0.94 - 1.00)	(0.94 - 1.00)	(0.94 - 1.00)	(0.93 - 1.00)
Married	1.11	1.11	1.07	1.07	1.10
	(0.81 - 1.51)	(0.81 - 1.50)	(0.79 - 1.46)	(0.79 - 1.46)	(0.81 - 1.49)
Military veteran	0.45***	0.44***	0.47***	0.47***	0.46***
Household income and assets [a]	(0.31 - 0.65)	(0.30 - 0.64)	(0.32 - 0.69)	(0.32 - 0.69)	(0.31 - 0.68)
Countable income ($10,000s)	1.16	1.17*	1.16	1.17*	1.15
	(0.96 - 1.39)	(0.97 - 1.41)	(0.96 - 1.39)	(0.98 - 1.41)	(0.96 - 1.39)
Countable assets ($10,000s)	0.97	0.97	0.98	0.98	0.98
	(0.93 - 1.01)	(0.94 - 1.01)	(0.94 - 1.01)	(0.94 - 1.01)	(0.94 - 1.01)
Cognition score (0-worst, 35-best)	1.03**				1.02**

Cognition Quartiles	(1.00 - 1.05)				(1.00 - 1.04)
1st Quartile (0-13)		-			
2nd Quartile (14-17)		1.15			
		(0.89 - 1.48)			
3rd Quartile (18-21)		1.41***			
		(1.11 - 1.78)			
4th Quartile (22-35)		1.61***			
		(1.20 - 2.16)			
Numeracy score (0-worst, 3-best)			1.21**		1.15*
Numeracy Categories			(1.02 - 1.42)		(0.98 - 1.35)
0/3				-	
				-	
1/3				1.38***	
				(1.10 - 1.74)	
2/3 – 3/3				1.33	
				(0.94 - 1.90)	
Depressed based on CESD scale[b]	1.12	1.12	1.10	1.11	1.13
	(0.91 - 1.38)	(0.91 - 1.38)	(0.89 - 1.35)	(0.90 - 1.36)	(0.92 - 1.38)
Some difficulties on two or more ADLs[c]	1.01	1.01	0.98	0.98	0.99
Self-reported chronic conditions	(0.77 - 1.34)	(0.76 - 1.34)	(0.74 - 1.30)	(0.74 - 1.30)	(0.75 - 1.32)
Hypertension	1.59***	1.59***	1.59***	1.59***	1.60***
	(1.24 - 2.03)	(1.25 - 2.04)	(1.24 - 2.03)	(1.24 - 2.03)	(1.24 - 2.05)
Diabetes	1.28*	1.28*	1.28*	1.28*	1.29**
	(0.99 - 1.65)	(0.99 - 1.65)	(0.99 - 1.65)	(0.99 - 1.64)	(1.00 - 1.67)
Any cancer, except skin cancer	1.03	1.02	1.03	1.03	1.02
	(0.74 - 1.42)	(0.74 - 1.42)	(0.75 - 1.41)	(0.75 - 1.42)	(0.74 - 1.41)
COPD	1.27*	1.27*	1.26	1.26	1.24
	(0.98 - 1.65)	(0.98 - 1.66)	(0.95 - 1.67)	(0.94 - 1.68)	(0.94 - 1.64)
Coronary heart disease or other heart problems	0.94	0.94	0.97	0.97	0.96
	(0.78 - 1.14)	(0.78 - 1.14)	(0.80 - 1.17)	(0.80 - 1.18)	(0.79 - 1.16)
Stroke	0.88	0.89	0.84	0.84	0.86
	(0.65 - 1.20)	(0.66 - 1.20)	(0.62 - 1.13)	(0.62 - 1.13)	(0.63 - 1.18)
Psychiatric problems	1.12	1.13	1.12	1.12	1.14

	(0.88 - 1.43)	(0.88 - 1.44)	(0.88 - 1.43)	(0.88 - 1.42)	(0.90 - 1.46)
Arthritis	1.18	1.17	1.20	1.21	1.19
	(0.90 - 1.54)	(0.89 - 1.54)	(0.92 - 1.58)	(0.93 - 1.58)	(0.91 - 1.56)

COPD = Chronic Obstructive Pulmonary Disease, CESD= Center for Epidemiological Studies-Depression, ADLs = Activities of Daily Living.

[a] Countable income and assets refer to the income and assets that are counted towards the LIS eligibility once all exclusions have been applied.

[b] We considered participants to be depressed if they reported depressive symptoms in response to half or more of questions included in an abridged version of the Center for Epidemiologic Studies–Depression questionnaire.

[c] Activities of daily living include bathing, dressing, eating, getting in and out of bed, and walking across a room.

*** p<0.01, ** p<0.05, * p<0.1

Appendix Table 2: Results from logistic regression model predicting awareness of the LIS among LIS-eligible Part D enrollees

	(1) **Cognition score** OR (95% CI)	(2) **Cognition in quartiles** OR (95% CI)	(3) **Numeracy score** OR (95% CI)	(4) **Numeracy as categories** OR (95% CI)	(5) **Cognition score and numeracy score** OR (95% CI)
Year					
2008	-	-	-	-	-
2010	0.92	0.92	0.91	0.91	0.93
	(0.69 - 1.22)	(0.69 - 1.23)	(0.69 - 1.21)	(0.69 - 1.21)	(0.70 - 1.24)
Age	0.97**	0.97**	0.97***	0.97***	0.98**
	(0.95 – 1.00)	(0.95 - 1.00)	(0.94 - 0.99)	(0.94 - 0.99)	(0.95 – 1.00)
Female	1.773***	1.78**	2.05***	2.04***	1.92***
	(1.16 - 2.71)	(1.15 - 2.75)	(1.32 - 3.19)	(1.31 - 3.18)	(1.22 - 3.01)
Race/Ethnicity					
Non-Hispanic white	-	-	-	-	-
Non-Hispanic black	0.62***	0.61***	0.58***	0.58***	0.62***
	(0.45 - 0.86)	(0.44 - 0.84)	(0.41 - 0.82)	(0.41 - 0.82)	(0.44 - 0.88)
Hispanic	0.48*	0.44*	0.53	0.53	0.49
	(0.20 - 1.20)	(0.19 - 1.01)	(0.22 - 1.26)	(0.22 - 1.27)	(0.20 - 1.20)
Other	0.84	0.77	0.79	0.71	0.87
	(0.37 - 1.92)	(0.34 - 1.78)	(0.34 - 1.85)	(0.34 - 1.86)	(0.38 - 1.98)
Educational attainment	1.03	1.03	1.05**	1.05**	1.03
	(0.99 - 1.07)	(0.98 - 1.07)	(1.01 - 1.09)	(1.01 - 1.09)	(0.98 - 1.07)
Married	0.98	0.99	0.95	0.95	1.02
	(0.67 - 1.42)	(0.67 - 1.45)	(0.64 - 1.39)	(0.65 - 1.40)	(0.71 - 1.46)
Military veteran	1.06	1.02	1.13	1.14	1.07
	(0.61 - 1.86)	(0.56 - 1.84)	(0.64 - 1.98)	(0.64 - 2.00)	(0.59 - 1. 91)
Household income and assets [a]					
Countable income ($10,000s)	1.33*	1.29*	1.41**	1.40**	1.34*
	(0.97 - 1.83)	(0.95 - 1.74)	(1.01 - 1.95)	(1.01 - 1.93)	(0.96 - 1.87)
Countable assets ($10,000s)	0.94	0.95	0.97	0.97	0.96
	(0.82 - 1.08)	(0.86 - 1.04)	(0.92 - 1.01)	(0.92 - 1.01)	(0.91 - 1.02)
Cognition Score (0-worst, 35-best)	1.06***				1.05***
	(1.03 - 1.09)				(1.02 - 1.08)
Cognition Quartiles					

1st Quartile (0-13)		-			
2nd Quartile (14-17)		2.24**			
		(1.16 - 4.35)			
3rd Quartile (18-21)		2.70***			
		(1.64 - 4.42)			
4th Quartile (22-35)		2.80***			
		(1.60 - 4.90)			
Numeracy score (0-worst, 3-best)			1.20*		1.08
Numeracy Categories			(0.99 - 1.45)		(0.88 - 1.31)
0/3				-	
				-	
1/3				1.22	
				(0.89 - 1.68)	
2/3 – 3/3				1.49*	
				(0.96 - 2.32)	
Depressed based on CESD scale [b]	1.13	1.11	1.05	1.06	1.11
	(0.78 - 1.63)	(0.76 - 1.63)	(0.72 - 1.52)	(0.73 - 1.54)	(0.76 - 1.61)
Some difficulties on two or more ADLs [c]	1.15	1.16	1.14	1.14	1.17
Self-reported chronic conditions	(0.75 - 1.76)	(0.74 - 1.80)	(0.74 - 1.75)	(0.74 - 1.76)	(0.76 - 1.80)
Hypertension	0.96	0.97	0.94	0.95	0.96
	(0.65 - 1.44)	(0.65 - 1.44)	(0.64 - 1.39)	(0.65 - 1.39)	(0.64 - 1.43)
Diabetes	0.98	1.00	0.96	0.97	0.98
	(0.66 - 1.44)	(0.68 - 1.46)	(0.66 - 1.41)	(0.66 - 1.42)	(0.66 - 1.46)
Any cancer, except skin cancer	1.19	1.21	1.16	1.17	1.17
	(0.80 - 1.78)	(0.80 - 1.85)	(0.78 - 1.72)	(0.79 - 1.74)	(0.78 - 1.76)
COPD	0.91	0.90	0.94	0.95	0.92
	(0.55 - 1.51)	(0.55 - 1.49)	(0.56 - 1.59)	(0.56 - 1.60)	(0.54 - 1.56)
Coronary heart disease or other heart problems	1.18	1.18	1.20	1.20	1.20
	(0.81 - 1.71)	(0.81 - 1.71)	(0.83 - 1.74)	(0.83 - 1.73)	(0.82 - 1.76)
Stroke	1.06	1.09	0.96	0.96	1.01
	(0.63 - 1.79)	(0.64 - 1.86)	(0.58 - 1.60)	(0.58 - 1.59)	(0.59 - 1.72)
Psychiatric problems	0.76	0.76	0.79	0.79	0.79
	(0.53 - 1.08)	(0.53 - 1.07)	(0.55 - 1.14)	(0.55 - 1.13)	(0.55- 1.13)
Arthritis	1.25	1.19	1.30	1.30	1.25

	(0.83 - 1.87)	(0.79 - 1.79)	(0.87 - 1.94)	(0.86 - 1.95)	(0.83 - 1.88)

COPD = Chronic Obstructive Pulmonary Disease, CESD= Center for Epidemiological Studies-Depression, ADLs = Activities of Daily Living.

[a] Countable income and assets refer to the income and assets that are counted towards the LIS eligibility once all exclusions have been applied.

[b] We considered participants to be depressed if they reported depressive symptoms in response to half or more of questions included in an abridged version of the Center for Epidemiologic Studies–Depression questionnaire.

[c] Activities of daily living include bathing, dressing, eating, getting in and out of bed, and walking across a room.

*** p<0.01, ** p<0.05, * p<0.1

Appendix Table 3: Results from logistic regression model predicting application for the LIS among LIS-eligible Part D enrollees

	(1) **Cognition score** OR (95% CI)	(2) **Cognition in quartiles** OR (95% CI)	(3) **Numeracy score** OR (95% CI)	(4) **Numeracy as categories** OR (95% CI)	(5) **Cognition score and numeracy score** OR (95% CI)
Year					
2006	-	-	-	-	-
2008	1.21	1.19	1.18	1.19	1.20
	(0.88 - 1.65)	(0.87 - 1.63)	(0.87 - 1.61)	(0.88 - 1.61)	(0.87 - 1.67)
2010	1.33*	1.33*	1.30*	1.30*	1.33*
	(0.99 - 1.79)	(1.00 - 1.78)	(0.98 - 1.74)	(0.98 - 1.74)	(0.99 - 1.79)
Age	0.96***	0.96***	0.96***	0.96***	0.96***
	(0.94 - 0.98)	(0.94 - 0.98)	(0.94 - 0.98)	(0.94 - 0.98)	(0.94 - 0.98)
Female	1.51*	1.50*	1.66**	1.62**	1.55**
	(0.99 - 2.31)	(0.99 - 2.27)	(1.07 - 2.56)	(1.04 - 2.53)	(1.01 - 2.37)
Race/Ethnicity					
Non-Hispanic white	-	-	-	-	-
Non-Hispanic black	0.74	0.73	0.73*	0.70*	0.76
	(0.51 - 1.08)	(0.50 - 1.07)	(0.51 - 1.05)	(0.49 - 1.01)	(0.52 - 1.11)
Hispanic	0.52	0.51	0.53	0.53	0.50
	(0.23 - 1.19)	(0.22 - 1.17)	(0.23 - 1.25)	(0.23 - 1.23)	(0.21 - 1.19)
Other	1.01	0.97	0.98	0.93	1.04
	(0.37 - 2.75)	(0.36 - 2.62)	(0.36 - 2.65)	(0.34 - 2.53)	(0.39 - 2.80)
Educational attainment	1.00	1.00	1.01	1.02	1.00
	(0.94 - 1.07)	(0.95 - 1.06)	(0.96 - 1.08)	(0.96 - 1.09)	(0.94 - 1.06)
Married	1.24	1.22	1.15	1.15	1.24
	(0.91 - 1.69)	(0.89 - 1.67)	(0.84 - 1.57)	(0.84 - 1.58)	(0.91 - 1.69)
Military veteran	0.81	0.79	0.83	0.85	0.79
	(0.43 - 1.51)	(0.42 - 1.49)	(0.43 - 1.61)	(0.44 - 1.66)	(0.42 - 1.48)
Household income and assets [a]					
Countable income ($10,000s)	1.00	0.99	1.05	1.06	0.99
	(0.74 - 1.35)	(0.74 - 1.33)	(0.79 - 1.40)	(0.79 - 1.41)	(0.73 - 1.34)
Countable assets ($10,000s)	0.83**	0.83*	0.77***	0.77***	0.77***
	(0.69 - 1.00)	(0.69 - 1.00)	(0.64 - 0.93)	(0.64 - 0.93)	(0.63 - 0.93)
Cognition Score (0-worst, 35-best)	1.05***				1.04***

Cognition Quartiles	(1.03 - 1.08)				(1.02 - 1.07)
1st Quartile (0-13)		-			
2nd Quartile (14-17)		1.60**			
		(1.03 - 2.49)			
3rd Quartile (18-21)		2.11***			
		(1.35 - 3.32)			
4th Quartile (22-35)		2.36***			
		(1.54 - 3.63)			
Numeracy score (0-worst, 3-best)			1.31***		1.20*
Numeracy Categories			(1.09 - 1.57)		(1.00 - 1.44)
0/3				-	
				-	
1/3				1.09	
				(0.80 - 1.50)	
2/3 – 3/3				1.80***	
				(1.17 - 2.79)	
Depressed based on CESD scale [b]	1.20	1.21	1.16	1.18	1.24
	(0.90 - 1.61)	(0.90 - 1.62)	(0.87 - 1.56)	(0.88 - 1.60)	(0.91 - 1.68)
Some difficulties on two or more ADLs [c]	0.87	0.86	0.84	0.84	0.88
Self-reported chronic conditions	(0.57 - 1.31)	(0.56 - 1.30)	(0.56 - 1.25)	(0.57 - 1.25)	(0.58 - 1.32)
Hypertension	1.36	1.37	1.29	1.28	1.33
	(0.82 - 2.26)	(0.83 - 2.28)	(0.77 - 2.15)	(0.77 - 2.15)	(0.79 - 2.22)
Diabetes	1.20	1.19	1.19	1.18	1.20
	(0.84 - 1.70)	(0.84 - 1.69)	(0.84 - 1.69)	(0.84 - 1.67)	(0.84 - 1.71)
Any cancer, except skin cancer	1.43*	1.43*	1.36*	1.38*	1.37*
	(0.99 - 2.05)	(0.99 - 2.06)	(0.94 - 1.96)	(0.96 - 1.99)	(0.94 - 1.99)
COPD	1.04	1.04	1.01	1.03	1.02
	(0.68 - 1.60)	(0.67 - 1.60)	(0.67 - 1.54)	(0.68 - 1.57)	(0.66 - 1.57)
Coronary heart disease or other heart problems	1.03	1.02	1.04	1.03	1.02
	(0.78 - 1.36)	(0.77 - 1.35)	(0.80 - 1.36)	(0.79 - 1.35)	(0.77 - 1.33)
Stroke	0.89	0.90	0.80	0.79	0.84
	(0.53 - 1.49)	(0.53 - 1.53)	(0.47 - 1.37)	(0.47 - 1.35)	(0.49 - 1.43)
Psychiatric problems	0.89	0.89	0.90	0.89	0.89

	(0.63 - 1.26)	(0.63 - 1.26)	(0.63 - 1.27)	(0.63 - 1.26)	(0.62 - 1.26)
Arthritis	1.61**	1.59**	1.60**	1.58**	1.57**
	(1.03 - 2.50)	(1.01 - 2.49)	(1.03 - 2.49)	(1.01 - 2.49)	(1.00 - 2.46)

COPD = Chronic Obstructive Pulmonary Disease, CESD= Center for Epidemiological Studies-Depression, ADLs = Activities of Daily Living.

[a] Countable income and assets refer to the income and assets that are counted towards the LIS eligibility once all exclusions have been applied.

[b] We considered participants to be depressed if they reported depressive symptoms in response to half or more of questions included in an abridged version of the Center for Epidemiologic Studies–Depression questionnaire.

[c] Activities of daily living include bathing, dressing, eating, getting in and out of bed, and walking across a room.

*** p<0.01, ** p<0.05, * p<0.1